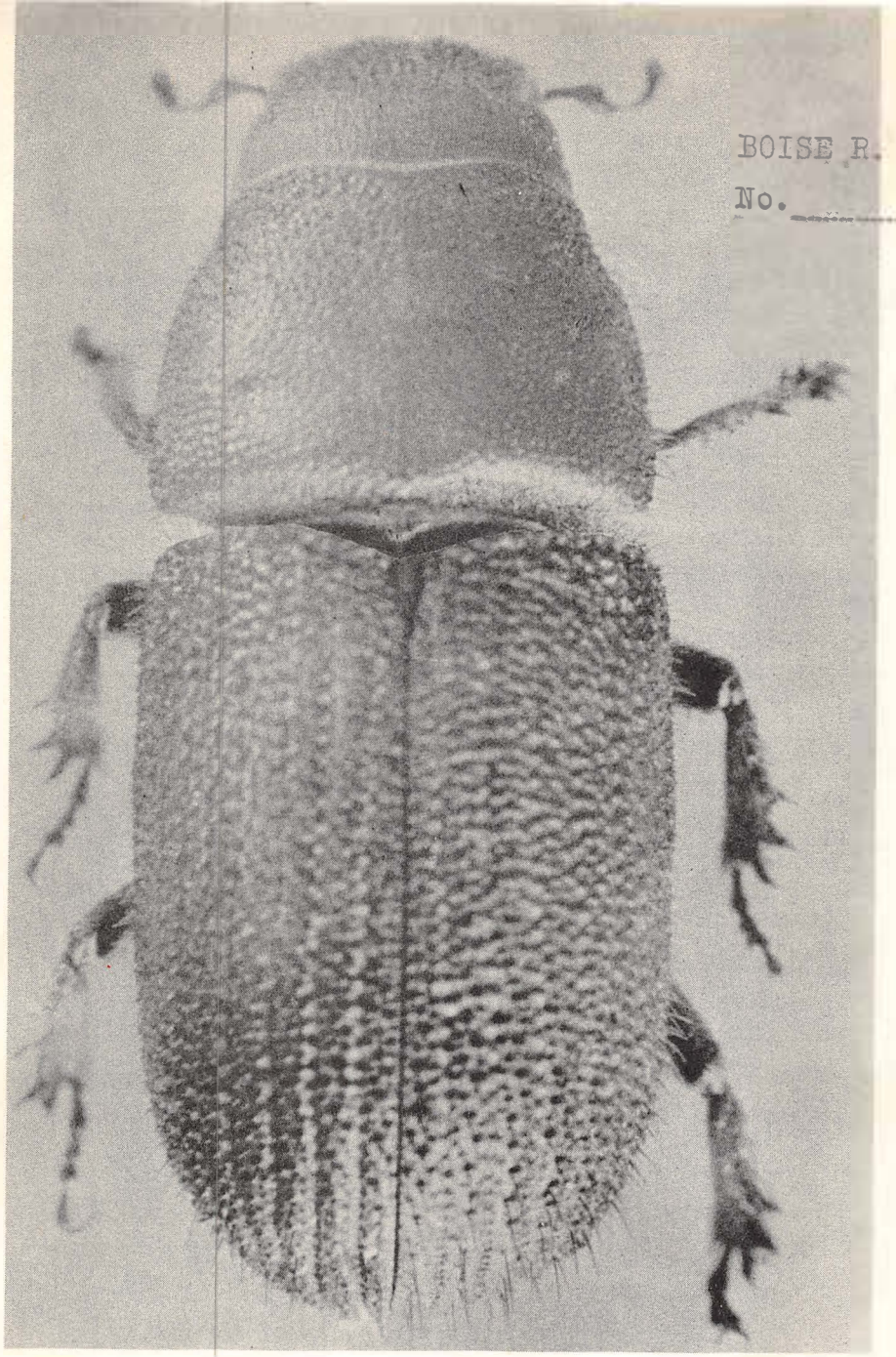
INTERMOUNTAIN STATION
Central Reference File
No. 3.4162

OCCASIONAL PAPER 138

1955



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THE BLACK TURPENTINE BEETLE, ITS HABITS AND CONTROL

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The photo on the cover shows an adult black turpentine beetle enlarged about 25 times. It was made by the Southern Regional Research Laboratory (New Orleans, La.), Agricultural Research Service, U. S. Department of Agriculture.

THE BLACK TURPENTINE BEETLE, ITS HABITS AND CONTROL

R. E. Lee [1/] and R. H. Smith [2/]

SUMMARY

The black turpentine beetle, long considered relatively harmless, has since 1949 been killing large numbers of pines throughout the Deep South, causing substantial losses to both timber growers and turpentine farmers.

Presence of this large, black or reddish-brown bark beetle is indicated by tubular masses of reddish pitch on fresh stumps and on the lower trunks of standing pines. Adult beetles deposit groups of eggs along tunnels in the inner bark. The larvae feed on the inner bark and often consume enough of it to girdle the tree. All species of southern pine are attacked.

The worst outbreaks have occurred in stands disturbed by either natural or man-made causes. The insect does not always confine itself to weakened trees, but kills apparently healthy ones as well. Other bark beetles, stain, and decay follow the turpentine beetle and develop so rapidly that the killed trees must be salvaged very promptly.

Tests with various insecticides show that spraying with solutions of benzene hexachloride (BHC) in fuel oil will prevent attack on stumps and trees. BHC also kills broods beneath the bark, though it may not save heavily infested trees. The effectiveness of stump treatments in reducing beetle populations has been demonstrated on large-scale control operations. It is not practical to use fire in controlling the beetle in stumps.

Attacks can be prevented or minimized by reducing or avoiding stand disturbances as much as possible, removing or spraying with BHC the trees injured in logging, promptly salvaging dead and dying

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1/ Southern Forest Experiment Station.
2/ Southeastern Forest Experiment Station.

trees, spraying stumps with BHC following salvage of infested trees or cutting of green trees in an outbreak area, and spraying seed trees in outbreak areas.

When insecticides are used to control the beetle, trustworthy men should be assigned to the sprayers, the insecticide should be prepared carefully, and the bark should be covered thoroughly with the spray. Spraymen should avoid all unnecessary contact with the insecticide.

THE BEETLE AND ITS HABITS

The black turpentine beetle (Dendroctonus terebrans (Oliver)) was one of two Dendroctonus species described in 1836 when the generic name was proposed. Dendroctonus means "killers of trees." The name is appropriate, for the 23 or more species that today represent the genus include some of the most destructive insect enemies of North American forests (2). 3/

Description and range. --Adults of the black turpentine beetle are larger than those of most of the other species of Dendroctonus, varying in length from 1/5 to 1/3 of an inch. They are hard-shelled, almost cylindrical in shape, and reddish-brown to black in color. The creamy-white larvae are legless and grub-like, attaining a maximum length of about 3/8 inch. The insect ranges from New Hampshire south through the Appalachians and throughout the range of the southern pines.

Host and site preferences. --Within the beetle's range, all species of pine, and red spruce as well, are attacked (1). The insect readily breeds in fresh stumps and in the lower trunk and roots of weakened trees. Populations sometimes build up rapidly, and then pines which appear to be healthy may be attacked. The beetle prefers large trees, seldom attacking those less than 3 inches in diameter.

Beetle activity usually centers in areas where some disturbance has occurred, and tree-killing commonly begins within one year of the disturbance.

H. R. Johnston and R. C. Morris, in an unpublished report of the Southern Forest Experiment Station, have pointed out that the most severe infestations occur on poorly drained sites. However, trees on upland areas are by no means immune.

Signs of attack. --The most obvious signs of attack are tubular masses of pitch on the lower trunk of trees and on stumps (fig. 1). At

3/ Underscored numbers in parentheses refer to Literature Cited, p. 14.

the base of the tree or stump may be found coarse particles of dried resin that have fallen from the pitch tubes.

If attack is sufficiently heavy the tree may die, the needles first turning pale yellow-green and then reddish-brown.

Figure 1. --Base of recently attacked tree, showing pitch tubes and black turpentine beetles.

Life history and habits. -- During warm periods, from 2-1/2 to 4 months are required in the Gulf States for development from egg to adult. There usually are two generations and part of a third each year. Broods overlap; with a mild winter the insect may remain active throughout the year. It is most active, however, from early spring to late fall.

When the beetle attacks, it bores through the outer bark to the living inner bark, where it seeks to excavate a longitudinal gallery (usually parallel to the grain of the wood) in which to breed. As the tunnel is extended, the beetle must remove the resin that flows into it from severed bark tissues. It does this by pushing tiny bits of resin and bark to the entrance hole, where a pitch tube is formed. When, on occasion, the beetle is overcome by the resin flow, it is said to be "pitched out." The quantity of gum produced by a tree, however, does not appear to affect its resistance to attack, for heavy gum producers such as longleaf and slash pine are killed as often as are loblolly and shortleaf pines.

The exact role of male and female in the construction and maintenance of the gallery is not known. It is thought that the male initiates attack and begins excavating the tunnel. Subsequently, one and occasionally two females join and assist him.

The gallery may exceed 20 inches in length. It is widened at points, and at each of the wide spaces the female deposits from 70 to 200 or more eggs. The eggs are laid on a soft cushion of pulverized bark which probably serves as an incubator and which may also protect the eggs from predators (2).

Figure 2. --Pupae and pupal cells of the black turpentine beetle.

In the Gulf States, during the warmer months, the eggs hatch after about ten days. The larvae feed gregariously on the inner bark. When several broods occur at approximately the same height on the trunk, they may girdle the tree.

When the larvae cease feeding, they form cells at the ends of their galleries and transform into pupae (fig. 2). In 10 to 14 days the pupae become adults. The young adults remain under the bark for a time, gradually changing from a very light amber to the color of the mature beetle. They then emerge to begin the life cycle anew--either by flying to new stumps or trees or by infesting green portions of the tree in which they developed.

Attacks on roots. --The beetle also attacks the roots of pines. In 1951, the soil was washed from the roots of four trees in Mississippi, and in 1953 a similar study was made on eight pines in east Texas. 4/ Root attacks were found as deep as 5 feet underground. They appeared to be limited only by root diameter: roots less than 1 inch thick were not attacked. The larger laterals and taproots of heavily infested trees had been extensively damaged. However, there appeared to have been little successful development of brood except on roots in the upper eighteen inches of the soil.

Because of the thinness of root bark, adult galleries were furrows through the bark rather than tunnels beneath it. The furrows were deep enough to cause the roots to "bleed," but the soil prevented the resin from flowing as it does above ground. As a result, galleries along the roots were covered by a hardened mixture of soil and resin.

4/ Acknowledgment is made to the Kirby Lumber Corporation, Houston, Texas, on whose lands the 1953 work was done, for providing a centrifugal pump and other assistance.

These studies suggested that frequency of attack on roots varies directly with frequency of attack above ground. Work in 1954 showed that this relationship does not always hold--several trees were found with heavy root attack and only light trunk attack.

The relationship of root attack to trunk attack needs intensive investigation. Does the initial infestation always occur above ground, or are the roots sometimes attacked first? Can the beetle spread from one tree to another along the roots? What effect do rainfall and the soil water table have upon the development of brood on roots? The answers might have an important bearing on control methods.

Tree-killing ability.--Prior to about 1949, the black turpentine beetle was regarded as a pest chiefly because of its habit of killing large patches of inner bark at the base of healthy pines (1). The aggressive tendencies that it has recently displayed were first observed by foresters and turpentine farmers in the Gulf States.

A report (unpublished) by Lloyd F. Smith, of damage on the McNeill Experimental Forest in south Mississippi, did much to focus attention on the insect. In June 1950, entomologists began keeping case histories on 82 of the infested longleaf pines at McNeill. By June 1951, 61 of the infested trees had died. Though limited in scope, this pioneering study nevertheless dramatized the deadliness of the beetle's new phase and yielded clues as to the conditions associated with attack.

Meanwhile, reports of unusual tree killing were accumulating to reveal outbreaks all across the lower South, from the Atlantic Coast into Texas.

In Louisiana, trees in a 125,000-acre tract of loblolly and spruce pine (Pinus glabra Walt.) became infested in 1949, and over 1,000,000 board feet of timber, plus additional pulpwood, was killed during the year. Further killing occurred in 1950. By 1951 trees were dying on over 40 percent of the area, and a volume of 2,000,000 board feet and 14,000 cords was killed before the end of the year. Through a well-organized program for controlling the beetle and salvaging dead trees, the owners averted much of the direct loss, but some 5,000 cords of pulpwood were too inaccessible and scattered to salvage.

In northern Florida, slash pine on pond sites has suffered a great deal. On areas up to 5 acres in size, losses have amounted to 30 to 50 percent of the volume, while losses of 5 to 10 percent have not been uncommon on larger areas. Severe infestations of loblolly and longleaf pine also have been observed in Alabama, Georgia, Mississippi, and east Texas.

Figure 3. --Tree heavily attacked by black turpentine beetles and associated insects. White deposit at base of tree is wood dust excavated by ambrosia beetles, which cause severe staining of wood.

On some intensively managed forests losses have threatened to upset the cutting budget, and the growing stock on many areas has been excessively reduced. There have been other serious effects. The stumpage price for the salvaged timber is usually less than for regular stumpage because the scattered distribution of the infested trees makes them costly to log. Moreover, unless salvage is prompt, stain, decay, and other insects increase the loss rapidly (fig. 3). When infestations follow improvement cuttings, losses are greater because only high-quality timber is attacked. Turpentine farmers also have suffered. Heavily infested trees yield little resin and usually die within a few months. Young trees reserved for future turpentining, as well as for crop trees, have been killed.

There is much to be learned regarding the role of this heretofore relatively harmless insect. While a great need exists for careful study of the host and environment, the beetle must also be investigated much more thoroughly than it has been. Genetic changes, such as occur in other insect species, may explain the beetle's new role--which may be only temporary but which could also be permanent.

The fact that this "well-known" insect suddenly became primary illustrates why the so-called lesser forest pests can never be taken for granted, and points up the need for intensive research on such insects.

INVESTIGATIONS OF CONTROL

Research was begun in 1950 to determine methods of controlling the

black turpentine beetle. These investigations were along two lines: (1) treatment of valuable individual trees that were only lightly infested, and (2) reduction of the general population in outbreak areas. J. F. Coyne was the first to attempt chemical treatment of living infested trees, and R. J. Kowal developed the stump-treating method that is now being used to reduce beetle populations (3, 4).

Treatment of individual trees. --Initial attempts to control the beetle were aimed primarily at saving living infested trees. In 1950, and again in 1951, formulations of benzene hexachloride (BHC) were applied as sprays to the infested trunks. These tests showed that water emulsions containing 0.40 percent of the gamma isomer gave poor results. Solutions containing 0.25 percent of the gamma isomer in No. 2 fuel oil 5/ killed the beetle brood but took effect so slowly that in severe infestations they failed to prevent tree mortality. Recent tests in Florida, however, indicate that increasing the concentration to 0.5 or even 1.0 percent kills the brood more rapidly and thus saves trees which otherwise might die (5).

The need for a method of protecting valuable uninfested trees, such as naval stores trees, seed trees, and trees in seed orchards, soon became apparent. It was found that a solution of 0.50 percent gamma isomer of BHC in fuel oil prevented attack on green stumps and trees for at least seven months. This treatment was successfully applied on the Osceola National Forest in Florida. Most of the beetle damage on that area had been confined to slash pine on pond sites where the trees were being worked for naval stores. The aim of the control program was to remove the susceptible trees and to keep the beetle population at a low level by treating all freshly cut stumps with BHC in oil. To insure a future stand of timber on the logged areas, the basal portions of seed trees, of which there are 3 to 4 per acre, were sprayed with the BHC solution. When more than 10,000 of these seed trees were examined recently, none were found to be attacked.

General reduction of beetle population. --In stumps and in trees mechanically injured, struck by lightning, or similarly damaged, the beetle breeds and develops large populations which later attack apparently vigorous trees. Two series of tests were established in 1951: (1) preventive, aimed at treating stumps immediately after cutting to prevent attack and, if possible, to kill the attacking beetles; (2) remedial, directed toward killing the broods already established in stumps.

5/ Directions for formulating the 0.25 percent gamma isomer solution of BHC are given on page 12.

In the preventive series, residual chlorinated hydrocarbon insecticides were applied to freshly cut stumps. The following chemicals were tested on two-acre areas: 2 percent chlordane in fuel oil; 2.5 percent DDT in fuel oil; 10 percent gamma isomer of BHC in dust form; 1 percent gamma isomer of wettable BHC in water; and 0.25 percent gamma isomer of BHC in fuel oil. Liquids were applied by spraying to the drip-point dosage--approximately 1 gallon per 100 square feet of bark. Dusts were applied at the rate of 1/2 pound per 100 square feet of bark. All stumps were approximately 11 inches high and 12 inches in diameter.

For the remedial tests, insecticides were applied to stumps about two months old and heavily infested with the beetle. Formulations and procedures were virtually the same as for the preventive tests except that BHC dust was omitted.

BHC gave superior results in both series of tests. In the preventive test, dust and wettable powder gave 98 and 96 percent control respectively; the fuel oil solution of BHC gave 92 percent control. Chlordane and DDT exerted only 66 and 47 percent control. In remedial tests, only BHC in fuel oil gave a creditable performance, exerting its chief influence upon the population as the beetles attempted to emerge through the bark. These tests indicated that under usual conditions, in which both infested and uninfested stumps exist, BHC in fuel oil is the best material.

In 1952 tests on 800 stumps in Florida and 400 in Mississippi confirmed this suggestion. In both States the oil solutions of BHC were superior to aqueous preparations or dusts for both preventive and remedial purposes.

Because of the thick bark on slash pines in Florida, all oil formulations for the Florida tests were in a 0.5 percent gamma isomer concentration. The addition of tall oil, turpentine, dipentine, and trichlorobenzene did little to increase the effectiveness of the basic oil solution. However, in Mississippi both 0.25 percent and 0.5 percent gamma isomer oil formulations were tested on longleaf pine stumps without appreciable difference in the results.

During the large Louisiana outbreak in 1949, efforts were made to control the beetle through prompt removal of infested trees. By 1950, some parts of the area had had as many as three salvage cuttings and the outbreak was still uncontrolled. In 1951, treatment of the infested stumps with BHC oil solutions was undertaken coincident with the salvage operation, and by the end of the year the beetle population

had declined markedly. Likewise, tree killing by this insect remained at a very low level on the area in 1952.

Use of fire. --In 1951 a small study was conducted to see if fire could be used to control the beetle. An area containing a number of heavily infested stumps was burned over by a "hot" fire, dried logging slash being piled on some stumps to increase the heat. The fire failed to destroy the infestation, and it was concluded that a burn hot enough to control the beetles would seriously injure residual trees on the area.

RECOMMENDATIONS FOR CONTROL

The following recommendations for controlling the beetle are necessarily general and must be applied with care. The amount of tree mortality within a stand varies with the beetle population and also with the vigor and possibly the species of the trees involved. Consequently, some modifications of these measures may be warranted, depending upon individual circumstances and management policy.

Indirect measures to prevent outbreaks. --Prevention by careful management is always better than cure by use of insecticides. Therefore:

1. Unnecessary disturbances in pine stands should be avoided. Woods operations should be conducted so as to prevent excessive injury to residual trees.

2. Stands disturbed by logging, turpentining, fire, hail, wind, lightning strikes, and other insects should be kept under observation for possible build-up in beetle population, especially during drought periods. Provision should be made for at least two inspections during the first year following the disturbance.

3. If disturbances occur, the more seriously damaged trees should be removed as quickly as possible. Skinned trees along skid trails, and others injured through logging, should be sprayed withBHC Many poorly drained areas can be logged only when dry. Because of the preference of the beetle for low, wet sites, special care should be taken to avoid logging damage to the residual stand.

4. Thinning or other conditioning of a stand prior to naval stores operation should be done, if possible, two years before working of the crop trees begins. If stands are thinned only one year before they are worked, the stumps should be treated with BHC. Thinning preferably should be done in the winter. As soon as facing is completed, the worked-out trees should be removed.

5. To prevent attack of high-value trees in an outbreak area, the lower boles should be treated with BHC. The height to which the

trees should be sprayed varies with the tree species and area. Where attacks commonly occur up to 10 or 12 feet above ground, preventive spraying should extend this high on the trunks. In most areas a high percentage of the attacks occur on the basal two feet of a tree, so that spraying to a height of six feet should suffice. Recent tests in Florida have shown that spraying in turpentine orchards can be confined to the basal two feet on slash pine and three feet on longleaf (on turpentine trees it is desirable to keep the amount of spraying to a minimum because the treatment may reduce gum flow). The spray deposit remains effective for six to seven months, after which respraying may be necessary if there is still a large beetle population in the area.

Direct measures to control outbreaks. --For areas where outbreaks have developed in spite of preventive measures or before the hazard is realized, the following suggestions are offered:

1. Trees that are dead or dying as a result of beetle attack should be salvaged as promptly as possible. A conservative guide to marking infested trees is to take only those with ambrosia beetle dust around the base, for these trees nearly always die. In some cases the landowner cannot afford to return to the area frequently and therefore may wish also to remove other heavily attacked trees which have not yet been infested by ambrosia beetles. If this is the case, care should be taken to ascertain that the turpentine beetle attacks are successful, with brood present in the tunnels, and have not been "pitched out." In all salvage cutting the trees should be cut close to the ground in order to remove the maximum number of beetles from the woods. The logs must be milled promptly and the slabs should be burned before the new beetle brood emerges. Stumps should be sprayed with BHC. In fact, if there is any chance that salvage will be delayed until after beetle emergence, it is better to spray the trees before cutting begins. This has the further advantage of eliminating the need for burning of the slabs.

2. Chemical treatment of living infested trees is not to be recommended indiscriminately. However, to save especially valuable trees (such as seed trees) that have become infested, prompt spraying of the trunk with BHC may prove effective, particularly if the trees have not been heavily attacked (fig. 4).

3. Logging, other than salvage, should not be conducted in the immediate vicinity of outbreaks unless provision can be made for spraying all green stumps (fig. 5).

Figure 4. --Valuable pine being sprayed to arrest existing infestation and to prevent future attack.

Figure 5.--Stump spraying with insecticide. Nozzle is held close to stump and its delivery rate is kept low to permit thorough spraying with minimum waste of chemical.

PREPARING AND APPLYING BHC

Materials and preparation. --No. 2 fuel oil is the recommended carrier for BHC. It is safe for use in most situations. Kerosene or other light oils should never be substituted for No. 2 fuel oil when living trees are to be treated, as they may kill the trees.

The BHC may be purchased either in commercial concentrates or as a technical grade chemical. The percent of gamma isomer specified for each product indicates the amount of effective material that it contains.

Preparation of the solutions is simple, but there are two very common sources of error--faulty measurement and failure to dissolve the technical BHC completely. Commercial concentrates, if formulated for this purpose, require only the addition of the fuel oil carrier plus slight stirring. Sprays made from technical grade BHC require a great deal of agitation but are less expensive. Permitting the fuel oil to warm in the sun for several hours before use aids in dissolving the BHC.

Concentrations recommended. --Most of the earlier tests with BHC for control of the black turpentine beetle were with a 0.25 percent solution of the gamma isomer in No. 2 fuel oil. This concentration will give effective control of the insect in relatively thin-barked trees or stumps and where the broods have developed sufficiently to cause the bark to loosen and become partly dried. However, for spraying green stumps or trees to prevent attack or to kill recently established broods, a 0.50 percent solution is considerably more effective. For thick-barked slash pine in Florida, it may be advisable to use a 1.0 percent solution (5).

Following are the amounts of various technical grades of BHC that should be dissolved in 50 gallons of No. 2 fuel oil to make a solution containing 0.25 percent of the gamma isomer. If a 0.50 or 1.0 percent solution is desired, these amounts should be multiplied by two or four.

Gamma isomer content of the BHC (percent)	Pounds needed
10	9
12	7-1/2
14	6
36	2-1/2

Spray application. --Common garden sprayers with an approximate capacity of 3-1/2 gallons are satisfactory for general use. The sprayer should have an oil-resistant hose. A small nozzle opening works best. A 50-gallon drum mounted on a jeep can be used to refill the sprayer.

Thorough coverage of the bark surface, especially in crevices, is necessary for good control. The spray should be applied until it begins to run off. To assure maximum benefits from each dollar spent, dependable men should be assigned to spray crews. The quality of the labor largely determines the success of the operation.

Many woodland grazing areas have been treated without apparent harm to cattle. Cattle are not attracted to stumps or trees treated with BHC.

Spray crews should take reasonable precautions to protect themselves. Oil solutions can be absorbed through the skin, and the BHC may irritate tender skin. After using the chemical, it is advisable to bathe in warm, soapy water. Things a sprayman will not have to worry about, however, are mosquitoes, chiggers, and ticks!

Cost. --The cost of treating stumps or trees depends upon the degree of refinement and the quantity of insecticide purchased, the source of supply, the cost of fuel oil, the cost of labor, and the distribution and number of trees or stumps to be treated.

On the average, four trees 8 inches in d. b. h. (or two trees 16 inches d. b. h.) can be sprayed to a height of 10 feet with one gallon of the fuel oil solution. About ten stumps, averaging 16 inches in diameter and 12 inches high, can be treated with one gallon of the solution. Trees or stumps with rough, thick bark may require twice this amount. Because the bark is thicker at the base, more liquid is needed to spray a stump of a given surface area than to treat a similar area higher on the bole. When fuel oil and insecticide are purchased in large quantities, a gallon of finished 0. 25 solution can be prepared for about 17 cents.

Sources of supply. --It is impractical to furnish a complete list of suppliers of BHC and sprayers. The following list is provided for the convenience of the reader. Many of these companies have local distributors. No discrimination is intended against firms not listed, and no guarantee of reliability is implied.

BHC

Ashcraft-Wilkinson Company, Atlanta 3, Georgia
Chapman Chemical Company, 707 Dermon Building, Memphis 3, Tennessee
Dow Chemical Company, Midland, Michigan
E. I. duPont deNemours and Company, Agricultural Chemical Division, Wilmington 98, Delaware
Ethyl Corporation, 100 Park Avenue, New York 17, New York
Florida Agricultural Supply Company, Box 658, Jacksonville, Florida
Mathieson Chemical Corporation, Box 991, Little Rock, Arkansas
Pennsylvania Salt Manufacturing Company, Bryan, Texas
Thompson-Hayward Chemical Company, 2915 Southwest Boulevard, Kansas City 8, Missouri

Sprayers

John Bean Manufacturing Company, Box 890, Lansing 4, Michigan
H. D. Hudson Manufacturing Company, 589 East Illinois Street, Chicago 11, Illinois
The F. E. Myers and Brother Company, 241 Fourth Street, Ashland, Ohio
D. B. Smith and Company, 440 Main Street, Utica 2, New York

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